"Normal form radioactive material" means radioactive material which has not been demonstrated to qualify as special form radioactive material.

"Packaging" means the assembly of components necessary to ensure compliance with the packaging requirements of this chapter. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

"Regulations of the U.S. Department of Transportation" means the regulations in 49 CFR Parts 100-189.

"Specific activity" of a radionuclide means the radioactivity of a radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

"Transport index" (TI) means the dimensionless number, rounded up to the first decimal place, placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number expressing the maximum radiation level in millirem per hour at one meter from the external surface of the package.

"Type A quantity" means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material, where A_1 and A_2 are given in Appendix E of this chapter or may be determined by procedures described in Appendix E of this chapter.

"Type B package" means a Type B packaging together with its radioactive contents. A Type B package design is designated as B(U) or B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, refer to 49 CFR Part 173. A Type B package approved prior to September 6, 1983, was designated only as Type B. Limitations on its use are specified in 39.5(8).

"Type B packaging" means a packaging designed to retain the integrity of containment and shielding when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR Part 71.

"Type B quantity" means a quantity of radioactive material greater than a Type A quantity.

39.5(3) *Requirement for license.* No person shall transport radioactive material or deliver radioactive material to a carrier for transport except as authorized in a general or specific license issued by the agency or as exempted in 39.5(4).

39.5(4) *Exemptions.*

a. Common and contract carriers, freight forwarders, and warehousers which are subject to the requirements of the U.S. Department of Transportation in 49 CFR 170 through 189 or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), Section 124.3 incorporated by reference, 39 CFR 111.11 (1974), and the U.S. Postal Service are exempt from the requirements of this chapter to the extent that they transport or store radioactive material in the regular course of their carriage for others or storage incident thereto. Common and contract carriers who are not subject to the requirements of the U.S. Department of Transportation or U.S. Postal Service are subject to 39.5(3) and other applicable requirements of 641—Chapters 38 to 46.

b. Any licensee is exempt from the requirements of this chapter to the extent that the licensee delivers to a carrier for transport a package containing radioactive material having a specific activity not greater than 0.002 microcurie per gram (74 Bq/gm).

c. With the exception of 39.5(5) and 39.5(16), a licensee is exempt from all requirements of this chapter, with respect to shipment or carriage of the following:

(1) A package containing no more than a Type A quantity of radioactive material if the package contains no fissile material; or

(2) Packages transported between locations within the United States which contain only americium or plutonium in special form with an aggregate radioactivity not to exceed 20 curies (740 GBq).

39.5(5) *Transportation of licensed material.*

a. Each licensee who transports licensed material outside the confines of the licensee's plant or other place of use, or who delivers licensed material to a carrier for transport, shall:

(1) Comply with the applicable requirements, appropriate to the mode of transport, of the regulations of the U.S. Department of Transportation; and

(2) Ensure that any special instructions needed to safely open the package are sent to or have been made available to the consignee.

b. If, for any reason, the regulations of the U.S. Department of Transportation are not applicable to a shipment of licensed material, the licensee shall conform to the standards and requirements of those regulations to the same extent as if the shipment was subject to the regulations.

39.5(6) *General licenses for carriers.*

a. A general license is hereby issued to any common or contract carrier not exempt under 39.5(4) to receive, possess, transport, and store radioactive material in the regular course of their carriage for others or storage incident thereto, provided the transportation and storage is in accordance with the applicable requirements, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in those U.S. Department of Transportation requirements shall be filed with, or made to, the agency.

b. A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with the applicable requirements, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in those U.S. Department of Transportation requirements shall be filed with, or made to, the agency.

c. Persons who transport radioactive material pursuant to the general licenses in 39.5(6)*"a"* or *"b"* are exempt from the requirements of 641—Chapter 40 to the extent that they transport radioactive material.

39.5(7) *General license—approved packages.*

a. A general license is hereby issued to any licensee of the agency to transport, or to deliver to a carrier for transport, licensed material in a package for which a license, certificate of compliance, or other approval has been issued by the U.S. Nuclear Regulatory Commission.

b. This general license applies only to a licensee who:

(1) Has a copy of the specific license, certificate of compliance, or other approval of the package and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment;

(2) Complies with the terms and conditions of the license, certificate, or other approval, as applicable, and the applicable requirements of this chapter;

(3) Prior to the licensee's first use of the package, has registered with the U.S. Nuclear Regulatory Commission; and

(4) Has a quality assurance program required by 39.5(20) and approved by the agency.

c. The general license in 39.5(7)*"a"* applies only when the package approval authorizes use of the package under this general license.

d. For previously approved Type B packages which are not designated as either B(U) or B(M) in the certificate of compliance, this general license is subject to additional restrictions of 39.5(8).

39.5(8) *General license—previously approved Type B packages.* A Type B package previously approved by the U.S. Nuclear Regulatory Commission, but not designated as B(U) or B(M) in the certificate of compliance, may be used under the general license of 39.5(7) with the following additional limitations:

a. Fabrication of the packaging was satisfactorily completed before August 31, 1986, as demonstrated by application of its model number in accordance with U.S. Nuclear Regulatory Commission regulations; and

b. The package may not be used for a shipment to a location outside the United States after August 31, 1986, except approved under special arrangement in accordance with 49 CFR 173.471.

39.5(9) *General license—specification container.*

a. A general license is issued to any licensee of the agency to transport, or to deliver to a carrier for transport, licensed material in a specification container for a Type B quantity of radioactive material as specified in 49 CFR Parts 173 and 178.

b. This general license applies only to a licensee who has a quality assurance program required by 39.5(20) and approved by the agency.

c. This general license applies only to a licensee who:

(1) Has a copy of the specification; and

(2) Complies with the terms and conditions of the specification and the applicable requirements of this chapter.

d. The general license in 39.5(9)*"a"* is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States after August 31, 1986, except approved under special arrangements in accordance with 49 CFR 173.472.

39.5(10) *General license—use of foreign approved package.*

a. A general license is issued to any licensee of the agency to transport, or to deliver to a carrier for transport, licensed material in a package, the design of which has been approved in a foreign national competent authority certificate which has been revalidated by the U.S. Department of Transportation as meeting the applicable requirements of 49 CFR 171.12.

b. This general license applies only to international shipments.

c. This general license applies only to a licensee who:

(1) Has a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment; and

(2) Complies with the terms and conditions of the certificate and revalidation and with the applicable requirements of 641—Chapter 39.

39.5(11) *General license—Type A, fissile Class II package.*

a. A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped as a fissile Class II package.

b. This general license applies only when a package contains no more than a Type A quantity of radioactive material, including only one of the following:

(1) Up to 40 grams of uranium-235; or

(2) Up to 30 grams of uranium-233; or

(3) Up to 25 grams of the fissile radionuclides of plutonium, except that for encapsulated plutonium-beryllium neutron sources in special form, an A_1 quantity of plutonium may be present; or

(4) A combination of fissile radionuclides in which the sum of the ratios of the amount of each radionuclide to the corresponding maximum amounts in 39.5(11)*"b"*(1), (2), and (3) does not exceed unity.

c. (1) Except as specified in 39.5(11)*"c"*(2), this general license applies only when a package containing more than 15 grams of fissile radionuclides is labeled with a transport index not less than the number given by the following equation:

$$\text{Minimum Transport Index} = (0.4x + 0.67y + z)\left(1 - \frac{15}{x+y+z}\right)$$

where the package contains x grams of uranium-235, y grams of uranium-233, and z grams of the fissile radionuclides of plutonium.

(2) For a package in which the only fissile material is in the form of encapsulated plutonium-beryllium neutron sources in special form, the transport index based on criticality considerations may be taken as 0.026 times the number of grams of the fissile radionuclides of plutonium in excess of 15 grams.

(3) In all cases, the transport index must be rounded up to one decimal place and may not exceed 10.0.

39.5(12) *General license—restricted, fissile Class II package.*

a. A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped as a fissile Class II package.

b. This general license applies only when all of the following requirements are met:

(1) The package contains no more than a Type A quantity of radioactive material.

(2) Neither beryllium nor hydrogenous material enriched in deuterium is present.

(3) The total mass of graphite present does not exceed 150 times the total mass of uranium-235 plus plutonium.

(4) Substances having a higher hydrogen density than water are not present, except that polyethylene may be used for packing or wrapping.

(5) Uranium-233 is not present, and the amount of plutonium does not exceed 1 percent of the amount of uranium-235.

(6) The amount of uranium-235 is limited as follows:

1. If the fissile radionuclides are not uniformly distributed, the maximum amount of uranium-235 per package may not exceed the value given in the following table:

Table 1

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
24	40
20	42
15	45
11	48
10	51
9.5	52
9	54
8.5	55
8	57
7.5	59
7	60
6.5	62
6	65
5.5	68
5	72
4.5	76
4	80
3.5	88
3	100
2.5	120

2	164
1.5	272
1.35	320
1	680*
0.92	1200*

*Pursuant to the agency's agreement with the U.S. Nuclear Regulatory Commission, jurisdiction extends only to 350 grams of uranium-235.

2. If the fissile radionuclides are distributed uniformly, the maximum amount of uranium-235 per package may not exceed the value given in the following table:

Table 2

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
4	84
3.5	92
3	112
2.5	148
2	240
1.5	560*
1.35	800*

*Pursuant to the agency's agreement with the U.S. Nuclear Regulatory Commission, jurisdiction extends only to 350 grams of uranium-235.

(7) The transport index of each package based on criticality considerations is taken as ten times the number of grams of uranium-235 in the package divided by the maximum allowable number of grams per package in accordance with Table 1 or 2 above as applicable.

39.5(13) *Fissile material—assumptions as to unknown properties.* When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee shall package the fissile material as if the unknown properties had credible values that would cause the maximum nuclear reactivity.

39.5(14) *Preliminary determinations.* Prior to the first use of any packaging for the shipment of radioactive material:

a. The licensee shall ascertain that there are no defects which could significantly reduce the effectiveness of the packaging;

b. Where the maximum normal operating pressure will exceed 34.3 kilopascal (5 psi) gauge, the licensee shall test the containment system at an internal pressure at least 50 percent higher than the maximum normal operating pressure to verify the capability of that system to maintain its structural integrity at that pressure;

c. The licensee shall determine that the packaging has been fabricated in accordance with the design approved by the U.S. Nuclear Regulatory Commission; and

d. The licensee shall conspicuously and durably mark the packaging with its model number, gross weight, and a package identification number assigned by the U.S. Nuclear Regulatory Commission.

39.5(15) *Routine determinations.* Prior to each shipment of licensed material, the licensee shall determine that:

a. The package is proper for the contents to be shipped;

b. The package is in unimpaired physical condition except for superficial defects such as marks or dents;

c. Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

d. Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

e. Any pressure relief device is operable and set in accordance with written procedures;

f. The package has been loaded and closed in accordance with written procedures;

g. Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies design requirements specified by the U.S. Nuclear Regulatory Commission;

h. (1) The level of removable radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable. The level of removable radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the removable contamination levels. Except as provided in 39.5(15)*"h"*(2), the amount of radioactivity measured on any single wiping material, when averaged over the surface wiped, must not exceed the limits given in Table 3 below at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used, the detection efficiency of the method used must be taken into account and in no case may the removable contamination on the external surfaces of the package exceed ten times the limits listed in Table 3.

Table 3

Removable External Radioactive
Contamination Wipe Limits

Contaminant	Maximum Permissible Limits $\mu Ci/cm^{2*}$	dpm/cm^2
Beta-gamma-emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates	10^{-5}	22
All other alpha-emitting radionuclides	10^{-6}	2.2

*To convert microcuries (μCi) to SI units of megabecquerels, multiply the values by 37.

(2) In the case of packages transported as exclusive use shipments by rail or highway only, the removable radioactive contamination at any time during transport must not exceed ten times the levels prescribed in 39.5(15)*"h"*(1). The levels at the beginning of transport must not exceed the levels in 39.5(15)*"h"*(1);

i. External radiation levels around the package and around the vehicle, if applicable, will not exceed 200 millirems per hour (2 mSv/h) at any point on the external surface of the package at any time during transportation. The transport index shall not exceed ten;

j. For a package transported in exclusive use by rail, highway or water, radiation levels external to the package may exceed the limits specified in 39.5(15)"*i*" but shall not exceed any of the following:

(1) 200 millirems per hour (2 mSv/h) on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1000 millirems per hour (10 mSv/h):

1. The shipment is made in a closed transport vehicle,
2. Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation, and
3. There are no loading or unloading operations between the beginning and end of the transportation;

(2) 200 millirems per hour (2 mSv/h) at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of a flat-bed style vehicle, with a personnel barrier,** at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure, if used) and on the lower external surface of the vehicle;

(3) 10 millirems per hour (0.1 mSv/h) at any point two meters from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of a flat-bed style vehicle, at any point two meters from the vertical planes projected from the outer edges of the vehicle; and

(4) 2 millirems per hour (0.02 mSv/h) in any normally occupied positions of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with 641—40.111(136C); and

**A flat-bed style vehicle with a personnel barrier shall have radiation levels determined at vertical planes. If no personnel barrier, the package cannot exceed 200 millirems per hour (2 mSv/h) at the surface.

k. A package must be prepared for transport so that in still air at 100 degrees Fahrenheit (38 degrees Celsius) and in the shade, no accessible surface of a package would have a temperature exceeding 122 degrees Fahrenheit (50 degrees Celsius) in a nonexclusive use shipment or 180 degrees Fahrenheit (82 degrees Celsius) in an exclusive use shipment. Accessible package surface temperatures shall not exceed these limits at any time during transportation.

39.5(16) *Air transport of plutonium.* Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this subrule or included indirectly by citation of the U.S. Department of Transportation regulations, as may be applicable, the licensee shall ensure that plutonium in any form is not transported by air, or delivered to a carrier for air transport, unless:

a. The plutonium is contained in a medical device designed for individual human application; or

b. The plutonium is contained in a material in which the specific activity is not greater than 0.002 microcuries per gram (74 Bq/gm) of material and in which the radioactivity is essentially uniformly distributed; or

c. The plutonium is shipped in a single package containing no more than an A_2 quantity of plutonium in any isotope or form and is shipped in accordance with 39.5(5); or

d. The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the certificate of compliance for that package issued by the U.S. Nuclear Regulatory Commission.

39.5(17) *Shipment records.* Each licensee shall maintain for a period of two years after shipment a record of each shipment of licensed material not exempt under 39.5(4), showing, where applicable:

a. Identification of the packaging by model number;

b. Verification that there were no significant defects in the packaging, as shipped;

c. Volume and identification of coolant;

d. Type and quantity of licensed material in each package, and the total quantity of each shipment;

e. Date of the shipment;

f. Name and address of the transferee;

g. Address to which the shipment was made; and

h. Results of the determinations required by 39.5(15).

39.5(18) *Reports.* The licensee shall report to the agency within 30 days:

a. Any instance in which there is significant reduction in the effectiveness of any authorized packaging during use; and

b. Details of any defects with safety significance in the packaging after first use, with the means employed to repair the defects and prevent their recurrence.

39.5(19) *Advance notification of transport of nuclear waste.*

a. Prior to the transport of any nuclear waste outside the confines of the licensee's facility or other place of use or storage, or prior to the delivery of any nuclear waste to a carrier for transport, each licensee shall provide advance notification of such transport to the governor, or governor's designee, of each state through which the waste will be transported. A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, State Programs, Office of Governmental and Public Affairs, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

b. Advance notification is required only when:

(1) The nuclear waste is required to be in Type B packaging for transportation;

(2) The nuclear waste is being transported to, through, or across state boundaries to a disposal site or to a collection point for transport to a disposal site; and

(3) The quantity of licensed material in a single package exceeds:

1. 5,000 curies (185 TBq) of special form radionuclides;

2. 5,000 curies (185 TBq) of uncompressed gases of argon-41, krypton-85m, krypton-87, xenon-131m, or xenon-135;

3. 50,000 curies (1.85 PBq) of argon-37, or of uncompressed gases of krypton-85 or xenon-133, or of hydrogen-3 as a gas, as luminous paint, or absorbed on solid material;

4. 20 curies (740 GBq) of other nonspecial form radionuclides for which A_2 is less than or equal to 4 curies (148 GBq); or

5. 200 curies (7.4 TBq) of other nonspecial form radionuclides for which A_2 is greater than 4 curies (148 GBq).

c. Each advance notification required by 39.5(19)*"a"* shall contain the following information:

(1) The name, address, and telephone number of the shipper, carrier, and receiver of the shipment;

(2) A description of the nuclear waste contained in the shipment as required by 49 CFR 172.202 and 172.203(d);

(3) The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(4) The seven-day period during which arrival of the shipment at state boundaries is estimated to occur;

(5) The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

(6) A point of contact with a telephone number for current shipment information.

d. The notification required by 39.5(19)*"a"* shall be made in writing to the office of each appropriate governor, or governor's designee, and to the agency. A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A notification delivered by messenger must reach the office of the governor, or governor's designee, at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A copy of the notification shall be retained by the licensee for one year.

e. The licensee shall notify each appropriate governor, or governor's designee, and the agency of any changes to schedule information provided pursuant to 39.5(19)*"a."* Such notification shall be by telephone to a responsible individual in the office of the governor, or governor's designee, of the ap-

propriate state or states. The licensee shall maintain for one year a record of the name of the individual contacted.

f. Each licensee who cancels a nuclear waste shipment, for which advance notification has been sent, shall send a cancellation notice to the governor, or governor's designee, of each appropriate state and to the agency. A copy of the notice shall be retained by the licensee for one year.

39.5(20) *Quality assurance requirements.*

a. Each licensee shall establish, maintain, and execute a quality assurance program to verify by procedures such as checking, auditing, and inspection that deficiencies, deviations, and defective material and equipment relating to the shipment of packages containing radioactive material are promptly identified and corrected.

b. The licensee shall identify the material and components to be covered by the quality assurance program.

c. Each licensee shall document the quality assurance program by written procedures or instructions and shall carry out the program in accordance with those procedures throughout the period during which packaging is used.

d. Prior to the use of any package for the shipment of radioactive material, each licensee shall obtain approval by the agency of its quality assurance program.

e. The licensee shall maintain sufficient written records to demonstrate compliance with the quality assurance program. Records of quality assurance pertaining to the use of a package for shipment of radioactive material shall be maintained for a period of two years after shipment.

CHAPTER 39—APPENDIX A
EXEMPT CONCENTRATIONS

Element (atomic number)	Radionuclide	Column I Gas concentration μCi/ml 1/	Column II Liquid and solid concentration μCi/ml 2/
Antimony (51)	Sb-122		3×10^{-4}
	Sb-124		2×10^{-4}
	Sb-125		1×10^{-3}
Argon (18)	Ar-37	1×10^{-3}	
	Ar-41	4×10^{-7}	
Arsenic (33)	As-73		5×10^{-3}
	As-74		5×10^{-4}
	As-76		2×10^{-4}
	As-77		8×10^{-4}
Barium (56)	Ba-131		2×10^{-3}
	Ba-140		3×10^{-4}
Beryllium (4)	Be-7		2×10^{-2}
Bismuth (83)	Bi-206		4×10^{-4}
Bromine (35)	Br-82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd-109		2×10^{-3}
	Cd-115m		3×10^{-4}
	Cd-115		3×10^{-4}
Calcium (20)	Ca-45		9×10^{-5}
	Ca-47		5×10^{-4}
Carbon (6)	C-14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce-141		9×10^{-4}
	Ce-143		4×10^{-4}
	Ce-144		1×10^{-4}
Cesium (55)	Cs-131		2×10^{-2}
	Cs-134m		6×10^{-2}
	Cs-134		9×10^{-5}
Chlorine (17)	Cl-38	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr-51		2×10^{-2}
Cobalt (27)	Co-57		5×10^{-3}
	Co-58		1×10^{-3}
	Co-60		5×10^{-4}
Copper (29)	Cu-64		3×10^{-3}
Dysprosium (66)	Dy-165		4×10^{-3}
	Dy-166		4×10^{-4}
Erbium (68)	Er-169		9×10^{-4}
	Er-171		1×10^{-3}
Europium (63)	Eu-152(9.2 h)		6×10^{-4}
	Eu-155		2×10^{-3}

Element (atomic number)	Radionuclide	Column I Gas concentration μCi/ml 1/	Column II Liquid and solid concentration μCi/ml 2/
Fluorine (9)	F-18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd-153		2×10^{-3}
	Gd-159		8×10^{-4}
Gallium (31)	Ga-72		4×10^{-4}
Germanium (32)	Ge-71		2×10^{-2}
Gold (79)	Au-196		2×10^{-3}
	Au-198		5×10^{-4}
	Au-199		2×10^{-3}
Hafnium (72)	Hf-181		7×10^{-4}
Hydrogen (1)	H-3	5×10^{-6}	3×10^{-2}
Indium (49)	In-113m		1×10^{-2}
	In-114m		2×10^{-4}
Iodine (53)	I-126	3×10^{-9}	2×10^{-5}
	I-131	3×10^{-9}	2×10^{-5}
	I-132	8×10^{-8}	6×10^{-4}
	I-133	1×10^{-8}	7×10^{-5}
	I-134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir-190		2×10^{-3}
	Ir-192		4×10^{-4}
	Ir-194		3×10^{-4}
Iron (26)	Fe-55		8×10^{-3}
	Fe-59		6×10^{-4}
Krypton (36)	Kr-85m	1×10^{-6}	
	Kr-85	3×10^{-6}	
Lanthanum (57)	La-140		2×10^{-4}
Lead (82)	Pb-203		4×10^{-3}
Lutetium (71)	Lu-177		1×10^{-3}
Manganese (25)	Mn-52		3×10^{-4}
	Mn-54		1×10^{-3}
	Mn-56		1×10^{-3}
Mercury (80)	Hg-197m		2×10^{-3}
	Hg-197		3×10^{-3}
	Hg-203		2×10^{-4}
Molybdenum (42)	Mo-99		2×10^{-3}
Neodymium (60)	Nd-147		6×10^{-4}
	Nd-149		3×10^{-3}
Nickel (28)	Ni-65		1×10^{-3}
Niobium (Columbium) (41)	Nb-95		1×10^{-3}
	Nb-97		9×10^{-3}
Osmium (76)	Os-185		7×10^{-4}

Element (atomic number)	Radionuclide	Column I Gas concentration μCi/ml 1/	Column II Liquid and solid concentration μCi/ml 2/
	Os-191m		3×10^{-2}
	Os-191		2×10^{-3}
	Os-193		6×10^{-4}
Palladium (46)	Pd-103		3×10^{-3}
	Pd-109		9×10^{-4}
Phosphorus (15)	P-32		2×10^{-4}
Platinum (78)	Pt-191		1×10^{-3}
	Pt-193m		1×10^{-2}
	Pt-197m		1×10^{-2}
	Pt-197		1×10^{-3}
Potassium (19)	K-42		3×10^{-3}
Praseodymium (59)	Pr-142		3×10^{-4}
	Pr-143		5×10^{-4}
Promethium (61)	Pm-147		2×10^{-3}
	Pm-149		4×10^{-4}
Rhenium (75)	Re-183		6×10^{-3}
	Re-186		9×10^{-4}
	Re-188		6×10^{-4}
Rhodium (45)	Rh-103m		1×10^{-1}
	Rh-105		1×10^{-3}
Rubidium (37)	Rb-86		7×10^{-4}
Ruthenium (44)	Ru-97		4×10^{-3}
	Ru-103		8×10^{-4}
	Ru-105		1×10^{-3}
	Ru-106		1×10^{-4}
Samarium (62)	Sm-153		8×10^{-4}
Scandium (21)	Sc-46		4×10^{-4}
	Sc-47		9×10^{-4}
	Sc-48		3×10^{-4}
Selenium (34)	Se-75		3×10^{-3}
Silicon (14)	Si-31		9×10^{-3}
Silver (47)	Ag-105		1×10^{-3}
	Ag-110m		3×10^{-4}
	Ag-111		4×10^{-4}
Sodium (11)	Na-24		2×10^{-3}
Strontium (38)	Sr-85		1×10^{-3}
	Sr-89		1×10^{-4}
	Sr-91		7×10^{-4}
	Sr-92		7×10^{-4}
Sulfur (16)	S-35	9×10^{-8}	6×10^{-4}

Element (atomic number)	Radionuclide	Column I Gas concentration μCi/ml 1/	Column II Liquid and solid concentration μCi/ml 2/
Tantalum (73)	Ta-182		4×10^{-4}
Technetium (43)	Tc-96m		1×10^{-1}
	Tc-96		1×10^{-3}
Tellurium (52)	Te-125m		2×10^{-3}
	Te-127m		6×10^{-4}
	Te-127		3×10^{-3}
	Te-129m		3×10^{-4}
	Te-131m		6×10^{-4}
	Te-132		3×10^{-4}
Terbium (65)	Tb-160		4×10^{-4}
Thallium (81)	Tl-200		4×10^{-3}
	Tl-201		3×10^{-3}
	Tl-202		1×10^{-3}
	Tl-204		1×10^{-3}
Thulium (69)	Tm-170		5×10^{-4}
	Tm-171		5×10^{-3}
Tin (50)	Sn-113		9×10^{-4}
	Sn-125		2×10^{-4}
Tungsten (Wolfram) (74)	W-181		4×10^{-3}
	W-187		7×10^{-4}
Vanadium (23)	V-48		3×10^{-4}
Xenon (54)	Xe-131m	4×10^{-6}	
	Xe-133	3×10^{-6}	
	Xe-135	1×10^{-6}	
Ytterbium (70)	Yb-175		1×10^{-3}
Yttrium (39)	Y-90		2×10^{-4}
	Y-91m		3×10^{-2}
	Y-91		3×10^{-4}
	Y-92		6×10^{-4}
	Y-93		3×10^{-4}
Zinc (30)	Zn-65		1×10^{-3}
	Zn-69m		7×10^{-4}
	Zn-69		2×10^{-2}
Zirconium (40)	Zr-95		6×10^{-4}
	Zr-97		2×10^{-4}
Beta- and/or gamma-emitting radioactive material not listed above with half-life of less than 3 years.		1×10^{-10}	1×10^{-6}

1/ Values are given in Column I only for those materials normally used as gases.

2/ μCi/g for solids.

NOTE 1: Many radionuclides transform into other radionuclides. In expressing the concentrations in Appendix A, the activity stated is that of the parent radionuclide and takes into account the radioactive decay products.

NOTE 2: For purposes of 39.4(3) where there is involved a combination of radionuclides, the limit for the combination should be derived as follows: Determine for each radionuclide in the product the ratio between the radioactivity concentration present in the product and the exempt radioactivity concentration established in Appendix A for the specific radionuclide when not in combination. The sum of such ratios may not exceed "1."

EXAMPLE: $\frac{\text{Concentration of Radionuclide A in Product}}{\text{Exempt concentration of Radionuclide A}} +$

$\frac{\text{Concentration of Radionuclide B in Product}}{\text{Exempt concentration of Radionuclide B}} < 1$

NOTE 3: To convert μCi/ml to SI units of megabecquerels per liter multiply the above values by 37.

EXAMPLE: Zirconium (40) Zr-97 (2×10^{-4} μCi/ml multiplied by 37 is equivalent to 74×10^{-4} MBq/l)

CHAPTER 39—APPENDIX B
EXEMPT QUANTITIES

Radioactive Material	Microcuries
Antimony-122 (Sb 122)	100
Antimony-124 (Sb 124)	10
Antimony-125 (Sb 125)	10
Arsenic-73 (As 73)	100
Arsenic-74 (As 74)	10
Arsenic-76 (As 76)	10
Arsenic-77 (As 77)	100
Barium-131 (Ba 131)	10
Barium-133 (Ba 133)	10
Barium-140 (Ba 140)	10
Bismuth-210 (Bi 210)	1
Bromine-82 (Br 82)	10
Cadmium-109 (Cd 109)	10
Cadmium-115m (Cd 115m)	10
Cadmium-115 (Cd 115)	100
Calcium-45 (Ca 45)	10
Calcium-47 (Ca 47)	10
Carbon-14 (C 14)	100
Cerium-141 (Ce 141)	100
Cerium-143 (Ce 143)	100
Cerium-144 (Ce 144)	1
Cesium-129 (Cs 129)	100
Cesium-131 (Cs 131)	1,000
Cesium-134m (Cs 134m)	100

Radioactive Material	Microcuries
Cesium-134 (Cs 134)	1
Cesium-135 (Cs 135)	10
Cesium-136 (Cs 136)	10
Cesium-137 (Cs 137)	10
Chlorine-36 (Cl 36)	10
Chlorine-38 (Cl 38)	10
Chromium-51 (Cr 51)	1,000
Cobalt-57 (Co 57)	100
Cobalt-58m (Co 58m)	10
Cobalt-58 (Co 58)	10
Cobalt-60 (Co 60)	1
Copper-64 (Cu 64)	100
Dysprosium-165 (Dy 165)	10
Dysprosium-166 (Dy 166)	100
Erbium-169 (Er 169)	100
Erbium-171 (Er 171)	100
Europium-152 (Eu 152)9.2h	100
Europium-152 (Eu 152)13 yr	1
Europium-154 (Eu 154)	1
Europium-155 (Eu 155)	10
Fluorine-18 (F 18)	1,000
Gadolinium-153 (Gd 153)	10
Gadolinium-159 (Gd 159)	100
Gallium-67 (Ga 67)	100
Gallium-72 (Ga 72)	10
Germanium-68 (Ge 68)	10
Germanium-71 (Ge 71)	100
Gold-195 (Au 195)	10
Gold-198 (Au 198)	100
Gold-199 (Au 199)	100
Hafnium-181 (Hf 181)	10
Holmium-166 (Ho 166)	100
Hydrogen-3 (H 3)	1,000
Indium-111 (In 111)	100
Indium-113m (In 113m)	100
Indium-114m (In 114m)	10
Indium-115m (In 115m)	100
Indium-115 (In 115)	10
Iodine-123 (I 123)	100
Iodine-125 (I 125)	1
Iodine-126 (I 126)	1
Iodine-129 (I 129)	0.1
Iodine-131 (I 131)	1
Iodine-132 (I 132)	10

Radioactive Material	Microcuries
Iodine-133 (I 133)	1
Iodine-134 (I 134)	10
Iodine-135 (I 135)	10
Iridium-192 (Ir 192)	10
Iridium-194 (Ir 194)	100
Iron-52 (Fe 52)	10
Iron-55 (Fe 55)	100
Iron-59 (Fe 59)	10
Krypton-85 (Kr 85)	100
Krypton-87 (Kr 87)	10
Lanthanum-140 (La 140)	10
Lutetium-177 (Lu 177)	100
Manganese-52 (Mn 52)	10
Manganese-54 (Mn 54)	10
Manganese-56 (Mn 56)	10
Mercury-197m (Hg 197m)	100
Mercury-197 (Hg 197)	100
Mercury-203 (Hg 203)	10
Molybdenum-99 (Mo 99)	100
Neodymium-147 (Nd 147)	100
Neodymium-149 (Nd 149)	100
Nickel-59 (Ni 59)	100
Nickel-63 (Ni 63)	10
Nickel-65 (Ni 65)	100
Niobium-93m (Nb 93m)	10
Niobium-95 (Nb 95)	10
Niobium-97 (Nb 97)	10
Osmium-185 (Os 185)	10
Osmium-191m (Os 191m)	100
Osmium-191 (Os 191)	100
Osmium-193 (Os 193)	100
Palladium-103 (Pd 103)	100
Palladium-109 (Pd 109)	100
Phosphorus-32 (P 32)	10
Platinum-191 (Pt 191)	100
Platinum-193m (Pt 193m)	100
Platinum-193 (Pt 193)	100
Platinum-197m (Pt 197m)	100
Platinum-197 (Pt 197)	100
Polonium-210 (Po 210)	0.1
Potassium-42 (K 42)	10
Potassium-43 (K 43)	10
Praseodymium-142 (Pr 142)	100
Praseodymium-143 (Pr 143)	100

Radioactive Material	Microcuries
Promethium-147 (Pm 147)	10
Promethium-149 (Pm 149)	10
Rhenium-186 (Re 186)	100
Rhenium-188 (Re 188)	100
Rhodium-103m (Rh 103m)	100
Rhodium-105 (Rh 105)	100
Rubidium-81 (Rb 81)	10
Rubidium-86 (Rb 86)	10
Rubidium-87 (Rb 87)	10
Ruthenium-97 (Ru 97)	100
Ruthenium-103 (Ru 103)	10
Ruthenium-105 (Ru 105)	10
Ruthenium-106 (Ru 106)	1
Samarium-151 (Sm 151)	10
Samarium-153 (Sm 153)	100
Scandium-46 (Sc 46)	10
Scandium-47 (Sc 47)	100
Scandium-48 (Sc 48)	10
Selenium-75 (Se 75)	10
Silicon-31 (Si 31)	100
Silver-105 (Ag 105)	10
Silver-110m (Ag 110m)	1
Silver-111 (Ag 111)	100
Sodium-22 (Na 22)	10
Sodium-24 (Na 24)	10
Strontium-85 (Sr 85)	10
Strontium-89 (Sr 89)	1
Strontium-90 (Sr 90)	0.1
Strontium-91 (Sr 91)	10
Strontium-92 (Sr 92)	10
Sulphur-35 (S 35)	100
Tantalum-182 (Ta 182)	10
Technetium-96 (Tc 96)	10
Technetium-97m (Tc 97m)	100
Technetium-97 (Tc 97)	100
Technetium-99m (Tc 99m)	100
Technetium-99 (Tc 99)	10
Tellurium-125m (Te 125m)	10
Tellurium-127m (Te 127m)	10
Tellurium-127 (Te 127)	100
Tellurium-129m (Te 129m)	10
Tellurium-129 (Te 129)	100
Tellurium-131m (Te 131m)	10
Tellurium-132 (Te 132)	10

Radioactive Material	Microcuries
Terbium-160 (Tb 160)	10
Thallium-200 (Tl 200)	100
Thallium-201 (Tl 201)	100
Thallium-202 (Tl 202)	100
Thallium-204 (Tl 204)	10
Thulium-170 (Tm 170)	10
Thulium-171 (Tm 171)	10
Tin-113 (Sn 113)	10
Tin-125 (Sn 125)	10
Tungsten-181 (W 181)	10
Tungsten-185 (W 185)	10
Tungsten-187 (W 187)	100
Vanadium-48 (V 48)	10
Xenon-131m (Xe 131m)	1,000
Xenon-133 (Xe 133)	100
Xenon-135 (Xe 135)	100

Radioactive Material	Microcuries
Ytterbium-175 (Yb 175)	100
Yttrium-87 (Y 87)	10
Yttrium-88 (Y 88)	10
Yttrium-90 (Y 90)	10
Yttrium-91 (Y 91)	10
Yttrium-92 (Y 92)	100
Yttrium-93 (Y 93)	100
Zinc-65 (Zn 65)	10
Zinc-69m (Zn 69m)	100
Zinc-69 (Zn 69)	1,000
Zirconium-93 (Zr 93)	10
Zirconium-95 (Zr 95)	10
Zirconium-97 (Zr 97)	10
Any radioactive material not listed above other than alpha-emitting radioactive material	0.1

NOTE 1: For purposes of 39.4(25)"*f*"(5)"2" where there is involved a combination of radionuclides, the limit for the combination should be derived as follows:

Determine the amount of each radionuclide possessed and 1,000 times the amount in Appendix B for each of those radionuclides when not in combination. The sum of the ratios of those quantities may not exceed 1.

EXAMPLE:

$$\frac{\text{Amt. of Radionuclide A possessed}}{1000 \times \text{Appendix B quantity for Radionuclide A}} + \frac{\text{Amt. of Radionuclide B possessed}}{1000 \times \text{Appendix B quantity for Radionuclide B}} \mu\ 1$$

NOTE 2: To convert microcuries (μCi) to SI units of kilobecquerels (kBq), multiply the above values by 37.

EXAMPLE: Zirconium-97 (10 μCi multiplied by 37 is equivalent to 370 kBq).

CHAPTER 39—APPENDIX C
Reserved

CHAPTER 39—APPENDIX D
LIMITS FOR BROAD LICENSES (39.4(28))

Radioactive Material	Column I curies	Column II curies
Antimony-122	1	0.01
Antimony-124	1	0.01
Antimony-125	1	0.01
Arsenic-73	10	0.1
Arsenic-74	1	0.01
Arsenic-76	1	0.01
Arsenic-77	10	0.1
Barium-131	10	0.1
Barium-140	1	0.01
Beryllium-7	10	0.1
Bismuth-210	0.1	0.001
Bromine-82	10	0.1
Cadmium-109	1	0.01
Cadmium-115m	1	0.01
Cadmium-115	10	0.1
Calcium-45	1	0.01
Calcium-47	10	0.1
Carbon-14	100	1.
Cerium-141	10	0.1

Radioactive Material	Column I curies	Column II curies
Cerium-143	10	0.1
Cerium-144	0.1	0.001
Cesium-131	100	1.
Cesium-134m	100	1.
Cesium-134	0.1	0.001
Cesium-135	1	0.01
Cesium-136	10	0.1
Cesium-137	0.1	0.001
Chlorine-36	1	0.01
Chlorine-38	100	1.
Chromium-51	100	1.
Cobalt-57	10	0.1
Cobalt-58m	100	1.
Cobalt-58	1	0.01
Cobalt-60	0.1	0.001
Copper-64	10	0.1
Dysprosium-165	100	1.
Dysprosium-166	10	0.1
Erbium-169	10	0.1
Erbium-171	10	0.1
Europium-152 (9.2 h)	10	0.1
Europium-152 (13 y)	0.1	0.001
Europium-154	0.1	0.001
Europium-155	1	0.01
Fluorine-18	100	1.
Gadolinium-153	1	0.01
Gadolinium-159	10	0.1

Gallium-72	10	0.1
Germanium-71	100	1.
Gold-198	10	0.1

Radioactive Material	Column I curies	Column II curies
Gold-199	10	0.1
Hafnium-181	1	0.01
Holmium-166	10	0.1
Hydrogen-3	100	1.
Indium-113m	100	1.
Indium-114m	1	0.01
Indium-115m	100	1.
Indium-115	1	0.01
Iodine-125	0.1	0.001
Iodine-126	0.1	0.001
Iodine-129	0.1	0.001
Iodine-131	0.1	0.001
Iodine-132	10	0.1
Iodine-133	1	0.01
Iodine-134	10	0.1
Iodine-135	1	0.01
Iridium-192	1	0.01
Iridium-194	10	0.1
Iron-55	10	0.1
Iron-59	1	0.01
Krypton-85	100	1.
Krypton-87	10	0.1
Lanthanum-140	1	0.01
Lutetium-177	10	0.1
Manganese-52	1	0.01
Manganese-54	1	0.01
Manganese-56	10	0.1

Radioactive Material	Column I curies	Column II curies
Mercury-197m	10	0.1
Mercury-197	10	0.1
Mercury-203	1	0.01
Molybdenum-99	10	0.1
Neodymium-147	10	0.1
Neodymium-149	10	0.1
Nickel-59	10	0.1
Nickel-63	1	0.01
Nickel-65	10	0.1
Niobium-93m	1	0.01
Niobium-95	1	0.01
Niobium-97	100	1.
Osmium-185	1	0.01
Osmium-191m	100	1.
Osmium-191	10	0.1
Osmium-193	10	0.1
Palladium-103	10	0.1
Palladium-109	10	0.1
Phosphorus-32	1	0.01
Platinum-191	10	0.1
Platinum-193m	100	1.
Platinum-193	10	0.1
Platinum-197m	100	1.
Platinum-197	10	0.1
Polonium-210	0.01	0.0001
Potassium-42	1	0.01
Praseodymium-142	10	0.1

Radioactive Material	Column I curies	Column II curies
Praseodymium-143	10	0.1
Promethium-147	1	0.01
Promethium-149	10	0.1
Radium-226	0.01	0.0001
Rhenium-186	10	0.1
Rhenium-188	10	0.1
Rhodium-103m	1,000	10.
Rhodium-105	10	0.1
Rubidium-86	1	0.01
Rubidium-87	1	0.01
Ruthenium-97	100	1.
Ruthenium-103	1	0.01
Ruthenium-105	10	0.1
Ruthenium-106	0.1	0.001
Samarium-151	1	0.01
Samarium-153	10	0.1
Scandium-46	1	0.01
Scandium-47	10	0.1
Scandium-48	1	0.01
Selenium-75	1	0.01
Silicon-31	10	0.1
Silver-105	1	0.01
Silver-110m	0.1	0.001
Silver-111	10	0.1
Sodium-22	0.1	0.001
Sodium-24	1	0.01
Strontium-85m	1,000	10.

Radioactive Material	Column I curies	Column II curies
Strontium-85	1	0.01
Strontium-89	1	0.01
Strontium-90	0.01	0.0001
Strontium-91	10	0.1
Strontium-92	10	0.1
Sulphur-35	10	0.1
Tantalum-182	1	0.01
Technetium-96	10	0.1
Technetium-97m	10	0.1
Technetium-97	10	0.1
Technetium-99m	100	1.
Technetium-99	1	0.01
Tellurium-125m	1	0.01
Tellurium-127m	1	0.01
Tellurium-127	10	0.1
Tellurium-129m	1	0.01
Tellurium-129	100	1.
Tellurium-131m	10	0.1
Tellurium-132	1	0.01
Terbium-160	1	0.01
Thallium-200	10	0.1
Thallium-201	10	0.1
Thallium-202	10	0.1
Thallium-204	1	0.01
Thulium-170	1	0.01
Thulium-171	1	0.01
Tin-113	1	0.01

Radioactive Material	Column I curies	Column II curies
Tin-125	1	0.01
Tungsten-181	1	0.01
Tungsten-185	1	0.01
Tungsten-187	10	0.1
Vanadium-48	1	0.01
Xenon-131m	1,000	10.
Xenon-133	100	1.
Xenon-135	100	1.
Ytterbium-175	10	0.1
Yttrium-90	1	0.01
Yttrium-91	1	0.01
Yttrium-92	10	0.1
Yttrium-93	1	0.01
Zinc-65	1	0.01
Zinc-69m	10	0.1
Zinc-69	100	1.
Zirconium-93	1	0.01
Zirconium-95	1	0.01
Zirconium-97	1	0.01
Any radioactive material other than source material, special nuclear material, or alpha-emitting radioactive material not listed above.	0.1	0.001

NOTE 1: To convert curies (Ci) to SI units of gigabecquerels (GBq), multiply the above values by 37.

EXAMPLE: Zirconium-97 (Col. II) (0.01 Ci multiplied by 37 is equivalent to 0.37 GBq).

CHAPTER 39—APPENDIX E
DETERMINATION OF A_1 AND A_2

I. Single Radionuclides.

1. For a single radionuclide of known identity, the values of A_1 and A_2 are taken from Table I if listed there. The values A_1 and A_2 in Table I are also applicable for the radionuclide contained in (a,n) or (c,n) neutron sources.

2. For any single radionuclide whose identity is known but which is not listed in Table I, the value of A_1 and A_2 is determined according to the following procedure:

(a) If the radionuclide emits only one type of radiation, A_1 is determined according to the following method. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in either case, A_1 is restricted to a maximum of 1000 curies (37 TBq). If a parent nuclide decays into a shorter lived daughter with a half-life not greater than ten days, A_1 is calculated for both the parent and the daughter, and the more limiting of the two values is assigned to the parent nuclide.

(1) For gamma emitters, A_1 is determined by the expression:

$A_1 = \frac{9}{C}$ curies

where C is the gamma-ray constant, corresponding to the dose in roentgens per curie-hour at 1 meter, and the number 9 results from the choice of 1 rem per hour at a distance of 3 meters as the reference dose-equivalent rate;

(2) For X-ray emitters, A_1 is determined by the atomic number of the nuclide:

for $Z \mu 55$, $A_1 = 1000$ Ci (37 TBq); and

for $Z > 55$, $A_1 = 200$ Ci (7.4 TBq)

where Z is the atomic number of the nuclide;

(3) For beta emitters, A_1 is determined by the maximum beta energy (E_{max}) according to Table II; and

(4) For alpha emitters, A_1 is determined by the expression:

$A_1 = 1000\ A_3$

where A_3 is the value listed in Table III;

(b) A_2 is the more restrictive of the following two values:

(1) The corresponding A_1; and

(2) The value A_3 obtained from Table III.

3. For any single radionuclide whose identity is unknown, the value of A_1 is taken to be 2 Ci (74 GBq) and the value of A_2 is taken to be 0.002 Ci (74 MBq). However, if the atomic number of the radionuclide is known to be less than 82, the value of A_1 is taken to be 10 Ci (370 GBq) and the value of A_2 is taken to be 0.4 Ci (14.8 GBq).

II. Mixtures of Radionuclides, Including Radioactive Decay Chains.

1. For mixed fission products, the activity limit may be assumed if a detailed analysis of the mixture is not carried out.

$A_1 = 10$ Ci (370 GBq)

$A_2 = 0.4$ Ci (14.8 GBq)

2. A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring proportions and no daughter nuclide has a half-life either longer than ten days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value from Table I to be applied are those corresponding to the parent nuclide of that chain.

When calculating A_1 or A_2 values, radiation emitted by daughters must be considered. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than ten days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.

3. In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide are known, the permissible activity of each radionuclide $R_1, R_2 \ldots R_n$ is such that $F_1 + F_2 + \ldots F_n$ is not greater than unity, where:

$$F_1 = \frac{\text{Total activity of } R_1}{A_i(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_i(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_i(R_n)} \text{ and}$$

$A_i (R_1, R_2 \ldots R_n)$ is the value of A_1 or A_2 as appropriate for the nuclide $R_1, R_2 \ldots R_n$.

4. When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in paragraph 3 above is applied to establish the values of A_1 or A_2 as appropriate. All the radionuclides whose individual activities are not known (their total activity will, however, be known) are classed in a single group and the most restrictive value of A_1 and A_2 applicable to any one of them is used as the value of A_1 or A_2 in the denominator of the fraction.

5. Where the identity of each radionuclide is known but the individual activity of none of the radionuclides is known, the most restrictive value of A_1 or A_2 applicable to any one of the radionuclides present is adopted as the applicable value.

6. When the identity of none of the nuclides is known, the value of A_1 is taken to be 2 Ci (74 GBq) and the value of A_2 is taken to be 0.002 Ci (74 MBq). However, if alpha emitters are known to be absent, the value of A_2 is taken to be 0.4 Ci (14.8 GBq).

Table I

A_1 and A_2 Values for Radionuclides
(See Footnotes at end of Table)

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Ac-227	Actinium (89)	1000	0.003	7.2×10^1
Ac-228		10	4	2.2×10^6
Ag-105	Silver (47)	40	40	3.1×10^4
Ag-110m		7	7	4.7×10^3
Ag-111		100	20	1.6×10^5
Am-241	Americium (95)	8	0.008	3.2
Am-243		8	0.008	1.9×10^{-1}
Ar-37 (compressed or uncompressed)*	Argon (18)	1000	1000	1.0×10^5
Ar-41 (uncompressed)*		20	20	4.3×10^7

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Ar-41 (compressed)*		1	1	4.3×10^7
As-73	Arsenic (33)	1000	400	2.4×10^4
As-74		20	20	1.0×10^5
As-76		10	10	1.6×10^6
As-77		300	20	1.1×10^6
At-211	Astatine (85)	200	7	2.1×10^6
Au-193	Gold (79)	200	200	9.3×10^5
Au-196		30	30	1.2×10^5
Au-198		40	20	2.5×10^5
Au-199		200	25	2.1×10^5
Ba-131	Barium (56)	40	40	8.7×10^4
Ba-133		40	40	4.0×10^2
Ba-140		20	20	7.3×10^4
Be-7	Beryllium (4)	300	300	3.5×10^5
Bi-206	Bismuth (83)	5	5	9.9×10^4
Bi-207		10	10	2.2×10^2
Bi-210 (RaE)		100	4	1.2×10^5
Bi-212		6	6	1.5×10^7
Bk-249	Berkelium (97)	1000	1	1.8×10^3
Br-77	Bromine (35)	70	25	7.1×10^5
Br-82		6	6	1.1×10^6
C-11	Carbon (6)	20	20	8.4×10^8
C-14		1000	60	4.6
Ca-45	Calcium (20)	1000	25	1.9×10^4
Ca-47		20	20	5.9×10^5
Cd-109	Cadmium (48)	1000	70	2.6×10^3
Cd-115m		30	30	2.6×10^4

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Cd-115		80	20	5.1×10^5
Ce-139	Cerium (58)	100	100	6.5×10^3
Ce-141		300	25	2.8×10^4
Ce-143		60	20	6.6×10^5
Ce-144		10	7	3.2×10^3
Cf-249	Californium (98)	2	0.002	3.1
Cf-250		7	0.007	1.3×10^2
Cf-252		2	0.009	6.5×10^2
Cl-36	Chlorine (17)	300	10	3.2×10^{-2}
Cl-38		10	10	1.3×10^8
Cm-242	Curium (96)	200	0.2	3.3×10^3
Cm-243		9	0.009	4.2×10^1
Cm-244		10	0.01	8.2×10^1
Cm-245		6	0.006	1.0×10^{-1}
Cm-246		6	0.006	3.6×10^{-1}
Co-56	Cobalt (27)	5	5	3.0×10^4
Co-57		90	90	8.5×10^3
Co-58m		1000	1000	5.9×10^6
Co-58		20	20	3.1×10^4
Co-60		7	7	1.1×10^3
Cr-51	Chromium (24)	600	600	9.2×10^4
Cs-129	Cesium (55)	40	40	7.6×10^5
Cs-131		1000	1000	1.0×10^5
Cs-134m		1000	10	7.4×10^6
Cs-134		10	10	1.2×10^3
Cs-135		1000	25	8.8×10^{-4}
Cs-136		7	7	7.4×10^4

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Cs-137		30	10	9.8×10^1
Cu-64	Copper (29)	80	25	3.8×10^6
Cu-67		200	25	7.9×10^5
Dy-165	Dysprosium (66)	100	20	8.2×10^6
Dy-166		1000	200	2.3×10^5
Er-169	Erbium (68)	1000	25	8.2×10^4
Er-171		50	20	2.4×10^6
Eu-152m	Europium (63)	30	30	2.2×10^6
Eu-152		20	10	1.9×10^2
Eu-154		10	5	1.5×10^2
Eu-155		400	60	1.4×10^3
F-18	Fluorine (9)	20	20	9.3×10^7
Fe-52	Iron (26)	5	5	7.3×10^6
Fe-55		1000	1000	2.2×10^3
Fe-59		10	10	4.9×10^4
Ga-67	Gallium (31)	100	100	6.0×10^5
Ga-68		20	20	4.0×10^7
Ga-72		7	7	3.1×10^6
Gd-153	Gadolinium (64)	200	100	3.6×10^3
Gd-159		300	20	1.1×10^6
Ge-68	Germanium (32)	20	10	7.0×10^3
Ge-71		1000	1000	1.6×10^5
H-3	Hydrogen (1)	(see T-Tritium)		
Hf-181	Hafnium (72)	30	25	1.6×10^4
Hg-197m	Mercury (80)	200	200	6.6×10^5
Hg-197		200	200	2.5×10^5
Hg-203		80	25	1.4×10^4

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Ho-166	Holmium (67)	30	30	6.9×10^5
I-123	Iodine (53)	50	50	1.9×10^6
I-125		1000	70	1.7×10^4
I-126		40	10	7.8×10^4
I-131		40	10	1.2×10^5
I-132		7	7	1.1×10^7
I-133		30	10	1.1×10^6
I-134		8	8	2.7×10^7
I-135		10	10	3.5×10^6
In-111	Indium (49)	30	25	4.2×10^5
In-113m		60	60	1.6×10^7
In-114m		30	20	2.3×10^4
In-115m		100	20	6.1×10^6
Ir-190	Iridium (77)	10	10	6.2×10^4
Ir-192		20	10	9.1×10^3
Ir-194		10	10	8.5×10^5
K-42	Potassium (19)	10	10	6.0×10^6
K-43		20	10	3.3×10^6
Kr-85m (uncompressed)*	Krypton (36)	100	100	8.4×10^6
Kr-85m (compressed)*		3	3	8.4×10^6
Kr-85 (uncompressed)*		1000	1000	4.0×10^2
Kr-85 (compressed)*		5	5	4.0×10^2
Kr-87 (uncompressed)*		20	20	2.8×10^7
Kr-87 (compressed)*		0.6	0.6	2.8×10^7
La-140	Lanthanum (57)	30	30	5.6×10^5
Lu-177	Lutetium (71)	300	25	1.1×10^5
MFP	Mixed Fission products	10	0.4	---

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Mg-28	Magnesium (12)	6	6	5.2×10^{6}
Mn-52	Manganese (25)	5	5	4.4×10^{5}
Mn-54		20	20	8.3×10^{3}
Mn-56		5	5	2.2×10^{7}
Mo-99	Molybdenum (42)	100	20	4.7×10^{5}
N-13	Nitrogen (7)	20	10	1.5×10^{9}
Na-22	Sodium (11)	8	8	6.3×10^{3}
Na-24		5	5	8.7×10^{6}
Nb-93m	Niobium (41)	1000	200	1.1×10^{3}
Nb-95		20	20	3.9×10^{4}
Nb-97		20	20	2.6×10^{7}
Nd-147	Neodymium (60)	100	20	8.0×10^{4}
Nd-149		30	20	1.1×10^{7}
Ni-59	Nickel (28)	1000	900	8.1×10^{-2}
Ni-63		1000	100	4.6×10^{1}
Ni-65		10	10	1.9×10^{7}
Np-237	Neptunium (93)	5	0.005	6.9×10^{-4}
Np-239		200	25	2.3×10^{5}
Os-185	Osmium (76)	20	20	7.3×10^{3}
Os-191		600	200	4.6×10^{4}
Os-191m		200	200	1.2×10^{6}
Os-193		100	20	5.3×10^{5}
P-32	Phosphorus (15)	30	30	2.9×10^{5}
Pa-230	Protactinium (91)	20	0.8	3.2×10^{4}
Pa-231		2	0.002	4.5×10^{-2}
Pa-233		100	100	2.1×10^{4}
Pb-201	Lead (82)	20	20	1.7×10^{6}

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Pb-210		100	0.2	8.8×10^{1}
Pb-212		6	5	1.4×10^{6}
Pd-103	Palladium (46)	1000	700	7.5×10^{4}
Pd-109		100	20	2.1×10^{6}
Pm-147	Promethium (61)	1000	25	9.4×10^{2}
Pm-149		100	20	4.2×10^{5}
Po-210	Polonium (84)	200	0.2	4.5×10^{3}
Pr-142	Praseodymium (59)	10	10	1.2×10^{4}
Pr-143		300	20	6.6×10^{4}
Pt-191	Platinum (78)	100	100	2.3×10^{5}
Pt-193m		200	200	2.0×10^{5}
Pt-197m		300	20	1.2×10^{7}
Pt-197		300	20	8.8×10^{5}
Pu-238	Plutonium (94)	3	0.003	1.7×10^{1}
Pu-239		2	0.002	6.2×10^{-2}
Pu-240		2	0.002	2.3×10^{-1}
Pu-241		1000	0.1	1.1×10^{2}
Pu-242		3	0.003	3.9×10^{-3}
Ra-223	Radium (88)	50	0.2	5.0×10^{4}
Ra-224		6	0.5	1.6×10^{5}
Ra-226		10	0.05	1.0
Ra-228		10	0.05	2.3×10^{2}
Rb-81	Rubidium (37)	30	24	8.2×10^{6}
Rb-86		30	30	8.1×10^{4}
Rb-87		Unlimited	Unlimited	6.6×10^{-8}
Rb (natural)		Unlimited	Unlimited	1.8×10^{-8}
Re-186	Rhenium (75)	100	20	1.9×10^{5}

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Re-187		Unlimited	Unlimited	3.8×10^{-8}
Re-188		10	10	1.0×10^{6}
Re (natural)		Unlimited	Unlimited	2.4×10^{-8}
Rh-103m	Rhodium (45)	1000	1000	3.2×10^{7}
Rh-105		200	25	8.2×10^{5}
Rn-222	Radon (86)	10	2	1.5×10^{5}
Ru-97	Ruthenium (44)	80	80	5.5×10^{5}
Ru-103		30	25	3.2×10^{4}
Ru-105		20	20	6.6×10^{6}
Ru-106		10	7	3.4×10^{3}
S-35	Sulphur (16)	1000	60	4.3×10^{4}
Sb-122	Antimony (51)	30	30	3.9×10^{5}
Sb-124		5	5	1.8×10^{4}
Sb-125		40	25	1.4×10^{3}
Sc-46	Scandium (21)	8	8	3.4×10^{4}
Sc-47		200	20	8.2×10^{5}
Sc-48		5	5	1.5×10^{6}
Se-75	Selenium (34)	40	40	1.4×10^{4}
Si-31	Silicon (14)	100	20	3.9×10^{7}
Sm-147	Samarium (62)	Unlimited	Unlimited	2.0×10^{-8}
Sm-151		1000	90	2.6×10^{1}
Sm-153		300	20	4.4×10^{5}
Sn-113	Tin (50)	60	60	1.0×10^{4}
Sn-119m		100	100	4.4×10^{3}
Sn-125		10	10	1.1×10^{5}
Sr-85m	Strontium (38)	80	80	3.2×10^{7}
Sr-85		30	30	2.4×10^{4}

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Sr-85m		50	50	1.2×10^{7}
Sr-89		100	10	2.9×10^{4}
Sr-90		10	0.4	1.5×10^{2}
Sr-91		10	10	3.6×10^{6}
Sr-92		10	10	1.3×10^{7}
T (uncompressed)*	Tritium (1)	1000	1000	9.7×10^{3}
T (compressed)*		1000	1000	9.7×10^{3}
T (activated luminous paint)		1000	1000	9.7×10^{3}
T (adsorbed on solid carrier)		1000	1000	9.7×10^{3}
T (tritiated water)		1000	1000	9.7×10^{3}
T (other forms)		20	20	9.7×10^{3}
Ta-182	Tantalum (73)	20	20	6.2×10^{3}
Tb-160	Terbium (65)	20	10	1.1×10^{4}
Tc-96m	Technetium (43)	1000	1000	3.8×10^{7}
Tc-96		6	6	3.2×10^{5}
Tc-97m		1000	200	1.5×10^{4}
Tc-97		1000	400	1.4×10^{-3}
Tc-99m		100	100	5.2×10^{6}
Tc-99		1000	25	1.7×10^{-2}
Te-125m	Tellurium (52)	1000	100	1.8×10^{4}
Te-127m		300	20	4.0×10^{4}
Te-127		300	20	2.6×10^{6}
Te-129m		30	10	2.5×10^{4}
Te-129		100	20	2.0×10^{7}
Te-131m		10	10	8.0×10^{5}
Te-132		7	7	3.1×10^{5}
Th-227	Thorium (90)	200	0.2	3.2×10^{4}

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
Th-228		6	0.008	8.3×10^{2}
Th-230		3	0.003	1.9×10^{-2}
Th-231		1000	25	5.3×10^{5}
Th-232		Unlimited	Unlimited	1.1×10^{-7}
Th-234		10	10	2.3×10^{4}
Th (natural)		Unlimited	Unlimited	2.2×10^{-7}
Th (irradiated)**		---	---	---
Tl-200	Thallium (81)	20	20	5.8×10^{5}
Tl-201		200	200	2.2×10^{5}
Tl-202		40	40	5.4×10^{4}
Tl-204		300	10	4.3×10^{2}
Tm-170	Thulium (69)	300	10	6.0×10^{3}
Tm-171		1000	100	1.1×10^{3}
U-230	Uranium (92)	100	0.1	2.7×10^{4}
U-232		30	0.03	2.1×10^{1}
U-233		100	0.1	9.5×10^{-3}
U-234		100	0.1	6.2×10^{-3}
U-235		100	0.2	2.1×10^{-6}
U-236		200	0.2	6.3×10^{-5}
U-238		Unlimited	Unlimited	3.3×10^{-7}
U (natural)		Unlimited	Unlimited	(see Table IV)
U (enriched) <20%		Unlimited	Unlimited	(see Table IV)
U (enriched) 20% or greater		100	0.1	(see Table IV)
U (depleted)		Unlimited	Unlimited	(see Table IV)
U (irradiated)***		---	---	---
V-48	Vanadium (23)	6	6	1.7×10^{5}
W-181	Tungsten (74)	200	100	5.0×10^{3}

Symbol of radionuclide	Element and atomic number	A_1(Ci)	A_2(Ci)	Specific activity (Ci/g)
W-185		1000	25	9.7×10^{-3}
W-187		40	20	7.0×10^{5}
Xe-127 (uncompressed)*	Xenon (54)	70	70	2.8×10^{4}
Xe-127 (compressed)*		5	5	2.8×10^{4}
Xe-131m (compressed)*		10	10	1.0×10^{5}
Xe-131m (uncompressed)*		100	100	1.0×10^{5}
Xe-133 (uncompressed)*		1000	1000	1.9×10^{5}
Xe-133 (compressed)*		5	5	1.9×10^{5}
Xe-135 (uncompressed)*		70	70	2.5×10^{5}
Xe-135 (compressed)*		2	2	2.5×10^{5}
Y-87	Yttrium (39)	20	20	4.5×10^{1}
Y-90		10	10	2.5×10^{5}
Y-91m		30	30	4.1×10^{7}
Y-91		30	30	2.5×10^{4}
Y-92		10	10	9.5×10^{6}
Y-93		10	10	3.2×10^{6}
Yb-169	Ytterbium (70)	80	80	2.3×10^{5}
Yb-175		400	25	1.8×10^{5}
Zn-65	Zinc (30)	30	30	8.0×10^{3}
Zn-69m		40	20	3.3×10^{6}
Zn-69		300	20	5.3×10^{7}
Zr-93	Zirconium (40)	1000	200	3.5×10^{-3}
Zr-95		20	20	2.1×10^{4}
Zr-97		20	20	2.0×10^{6}

* For the purpose of Table I, compressed gas means a gas at a pressure which exceeds the ambient atmospheric pressure at the location where the containment system was closed.

** The values of A_1 and A_2 must be calculated in accordance with the procedure specified in Appendix A, paragraph II, 3, taking into account the activity of the fission products and of the uranium-233 in addition to that of the thorium.

***The values of A_1 and A_2 must be calculated in accordance with the procedure specified in Appendix A, paragraph II, 3, taking into account the activity of the fission products and plutonium isotopes in addition to that of the uranium.

Table II

Relationship Between A_1 and E_{max} for Beta Emitters

E_{max}(MeV)	A_1(Ci)
< 0.5	1000
0.5 - < 1.0	300
1.0 - < 1.5	100
1.5 - < 2.0	30
2	10

Table III

Relationship Between A_3 and the Atomic Number of the Radionuclide

	A_3		
Atomic Number	Half-life less than 1000 days	Half-life 1000 days to 10^6 years	Half-life greater than 10^6 years
1 to 81	3 Ci	0.05 Ci	3 Ci
82 and above	0.002 Ci	0.002 Ci	3 Ci

Table IV

Activity-Mass Relationships for Uranium/Thorium

Thorium and Uranium Enrichment* wt % U-235 present	Specific Activity	
	Ci/g	g/Ci
0.45	5.0×10^{-7}	2.0×10^{6}
0.72 (natural)	7.06×10^{-7}	1.42×10^{6}
1.0	7.6×10^{-7}	1.3×10^{6}
1.50	1.0×10^{-6}	1.0×10^{6}
5.0	2.7×10^{-6}	3.7×10^{5}
10.0	4.8×10^{-6}	2.1×10^{5}
20.0	1.0×10^{-5}	1.0×10^{5}
35.0	2.0×10^{-5}	5.0×10^{4}
50.0	2.5×10^{-5}	4.0×10^{4}
90.0	5.8×10^{-5}	1.7×10^{4}
93.0	7.0×10^{-5}	1.4×10^{4}
95.0	9.1×10^{-5}	1.1×10^{4}
Natural Thorium	2.2×10^{-7}	4.6×10^{6}

*The figures for uranium include representative values for the activity of the uranium-234 which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium-228.

CHAPTER 39—APPENDIX F

Criteria Relating to Use of Financial Tests and Parent Company Guarantees for Providing Reasonable Assurance of Funds for Decommissioning

I. Introduction.

An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on obtaining a parent company guarantee that funds will be available for decommissioning costs and on a demonstration that the parent company passes a financial test. This appendix establishes criteria for passing the financial test and for obtaining the parent company guarantee.

II. Financial Test.

A. To pass the financial test, the parent company must meet the criteria of either paragraph A.1 or A.2 of this section:

1. The parent company must have:

(1) Two of the following three ratios: A ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; a ratio of current assets to current liabilities greater than 1.5; and

(2) Net working capital and tangible net worth each at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used); and

(3) Tangible net worth of at least $10 million; and

(4) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used).

2. The parent company must have:

(1) A current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard and Poor's or Aaa, Aa, or Baa as issued by Moody's; and

(2) Tangible net worth at least six times the current decommissioning cost estimate (or prescribed amount if a certification is used); and

(3) Tangible net worth of at least $10 million; and

(4) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used).

B. The parent company's independent certified public accountant must have compared the data used by the parent company in the financial test, which is derived from the independently audited, year-end financial statements for the latest fiscal year, with the amounts in such financial statement. In connection with that procedure the licensee shall inform BRH within 90 days or any matters coming to the auditor's attention which cause the auditor to believe that the data specified in the financial test should be adjusted and that the company no longer passes the test.

C.1. After the initial financial test, the parent company must repeat the passage of the test within 90 days after the close of each succeeding fiscal year.

2. If the parent company no longer meets the requirements of paragraph A of this section, the licensee must send notice to the BRH of intent to establish alternate financial assurance as specified in BRH rules. The notice must be sent by certified mail within 90 days after the end of the fiscal year for which the year-end financial data show that the parent company no longer meets the financial test requirements. The licensee must provide alternate financial assurance within 120 days after the end of such fiscal year.

III. Parent Company Guarantee.

The terms of a parent company guarantee which an applicant or licensee obtains must provide that:

A. The parent company guarantee will remain in force unless the guarantor sends notice of cancellation by certified mail to the licensee and the BRH. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the licensee and BRH, as evidenced by the return receipts.

B. If the licensee fails to provide alternate financial assurance as specified in BRH rules within 90 days after receipt by the licensee and BRH notice of cancellation of the parent company guarantee from the guarantor, the guarantor will provide such alternative financial assurance in the name of the licensee.

C. The parent company guarantee and financial test provisions must remain in effect until the BRH has terminated the license.

D. If a trust is established for decommissioning costs, the trustee and trust must be acceptable to BRH. An acceptable trustee includes an appropriate state or federal government agency or an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency.

APPENDIX G

QUANTITIES OF RADIOACTIVE MATERIALS REQUIRING CONSIDERATION OF THE NEED FOR AN EMERGENCY PLAN FOR RESPONDING TO A RELEASE

Radioactive Material	Release Fraction	Quantity (curies)
Actinium-228	0.001	4,000
Americium-241	.001	2
Americium-242	.001	2
Americium-243	.001	2
Antimony-124	.01	4,000
Antimony-126	.01	6,000
Barium-133	.01	10,000
Barium-140	.01	30,000
Bismuth-207	.01	5,000
Bismuth-210	.01	600
Cadmium-109	.01	1,000
Cadmium-113	.01	80
Calcium-45	.01	20,000
Californium-252	.001	9 (20 mg)
Carbon-14	.01	50,000
	Non CO	
Cerium-141	.01	10,000
Cerium-144	.01	300
Cesium-134	.01	2,000
Cesium-137	.01	3,000
Chlorine-36	.5	100
Chromium-51	.01	300,000
Cobalt-60	.001	5,000
Copper-64	.01	200,000
Curium-242	.001	60
Curium-243	.001	3
Curium-244	.001	4
Curium-245	.001	2
Europium-152	.01	500

Radioactive Material	Release Fraction	Quantity (curies)
Europium-154	.01	400
Europium-155	.01	3,000
Germanium-68	.01	2,000
Gadolinium-153	.01	5,000
Gold-198	.01	30,000
Hafnium-172	.01	400
Hafnium-173	.01	7,000
Holmium-166m	.01	100
Hydrogen-3	.5	20,000
Iodine-125	.5	10
Iodine-131	.5	10
Indium-114m	.01	1,000
Iridium-192	.001	40,000
Iron-55	.01	40,000
Iron-59	.01	7,000
Krypton-85	1.0	6,000,000
Lead-210	.01	8
Manganese-58	.01	60,000
Mercury-203	.01	10,000
Molybdenum-99	.01	30,000

Radioactive Material	Release Fraction	Quantity (curies)
Neptunium-237	.001	2
Nickel-63	.01	20,000
Niobium-94	.01	300
Phosphorus-32	.5	100
Phosphorus-33	.5	1,000
Polonium-210	.01	10
Potassium-42	.01	9,000
Promethium-145	.01	4,000
Promethium-147	.01	4,000
Ruthenium-106	.01	200
Samarium-151	.01	4,000
Scandium-46	.01	3,000
Selenium-75	.01	10,000
Silver-110m	.01	1,000
Sodium-22	.01	9,000
Sodium-24	.01	10,000
Strontium-89	.01	3,000
Strontium-90	.01	90
Sulfur-35	.5	900
Technetium-99	.01	10,000
Technetium-99m	.01	400,000
Tellurium-127m	.01	5,000
Tellurium-129m	.01	5,000
Terbium-160	.01	4,000
Thulium-170	.01	4,000
Tin-113	.01	10,000
Tin-123	.01	3,000
Tin-126	.01	1,000
Titanium-44	.01	100
Vanadium-48	.01	7,000
Xenon-133	1.0	900,000
Yttrium-91	.01	2,000
Zinc-65	.01	5,000
Zirconium-93	.01	400
Zirconium-95	.01	5,000
Any other beta-gamma emitter	.01	10,000
Mixed fission products	.01	1,000
Mixed corrosion products	.01	10,000
Contaminated equipment beta-gamma	.001	10,000
Irradiated material, any form other than solid noncombustible	.01	1,000
Irradiated material, solid noncombustible	.001	10,000

Radioactive Material	Release Fraction	Quantity (curies)
Mixed radioactive waste, beta-gamma	.01	1,000
Packaged mixed waste, beta-gamma[2]	.001	10,000
Any other alpha emitter	.001	2
Contaminated equipment, alpha	.0001	20
Packaged waste, alpha[2]	.0001	20
Combinations of radioactive materials listed above[1]	------	------

[1] For combinations of radioactive materials, consideration of the need for an emergency plan is required if the sum of the ratios of the quantity of each radioactive material authorized to the quantity listed for that material in Appendix G exceeds one.

[2] Waste packaged in Type B containers does not require an emergency plan.

These rules are intended to implement Iowa Code chapter 136C.

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